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(54) **Method and apparatus for adapting gasoline fuel burning engine to also burn a gaseous fuel.**

(57) A self regulating and balancing gas valve (32) is located in a fuel supply line (28) between a gaseous fuel storage container (26) and the intake manifold (29) of a fuel burning engine. The valve includes a diaphragm (30) which defines one wall of a chamber into which a gas inlet leads out from which a gas outlet leads. An accelerator pedal controlled valve (78) is positioned in the outlet, for controlling suction and the flow rate of gaseous fuel from the chamber in response to the position of the accelerator pedal. An inlet valve means (60) is provided to control the flow of gaseous fuel through the inlet into the chamber. This valve means includes a control means interconnected between the diaphragm and the inlet valve means, operable to open or increase the size of the inlet in response to inward movement of the diaphragm and to decrease or close the inlet in response to outward movement of the diaphragm. The metered gaseous fuel is delivered into the intake manifold closely adjacent to where the fuel mixture from the gasoline carburator discharges into the manifold. The gaseous fuel contacts incoming air at this location and mixes with it in the intake manifold.

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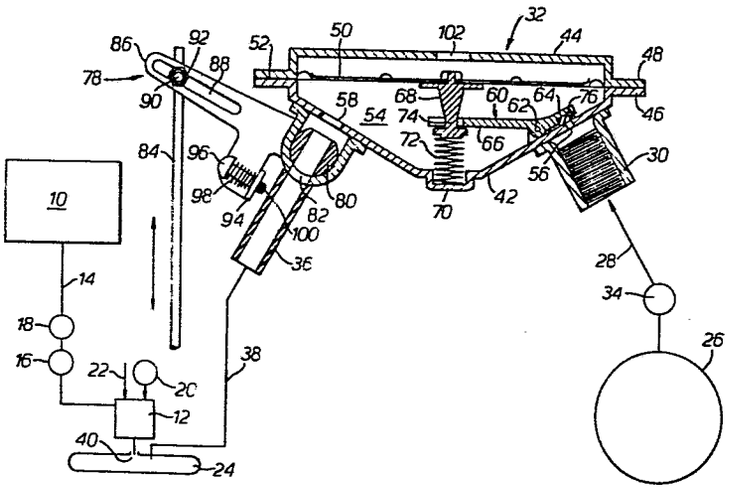
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METHOD AND APPARATUS FOR ADAPTING GASOLINE FUEL BURNING ENGINE TO ALSO BURN A GASEOUS FUEL

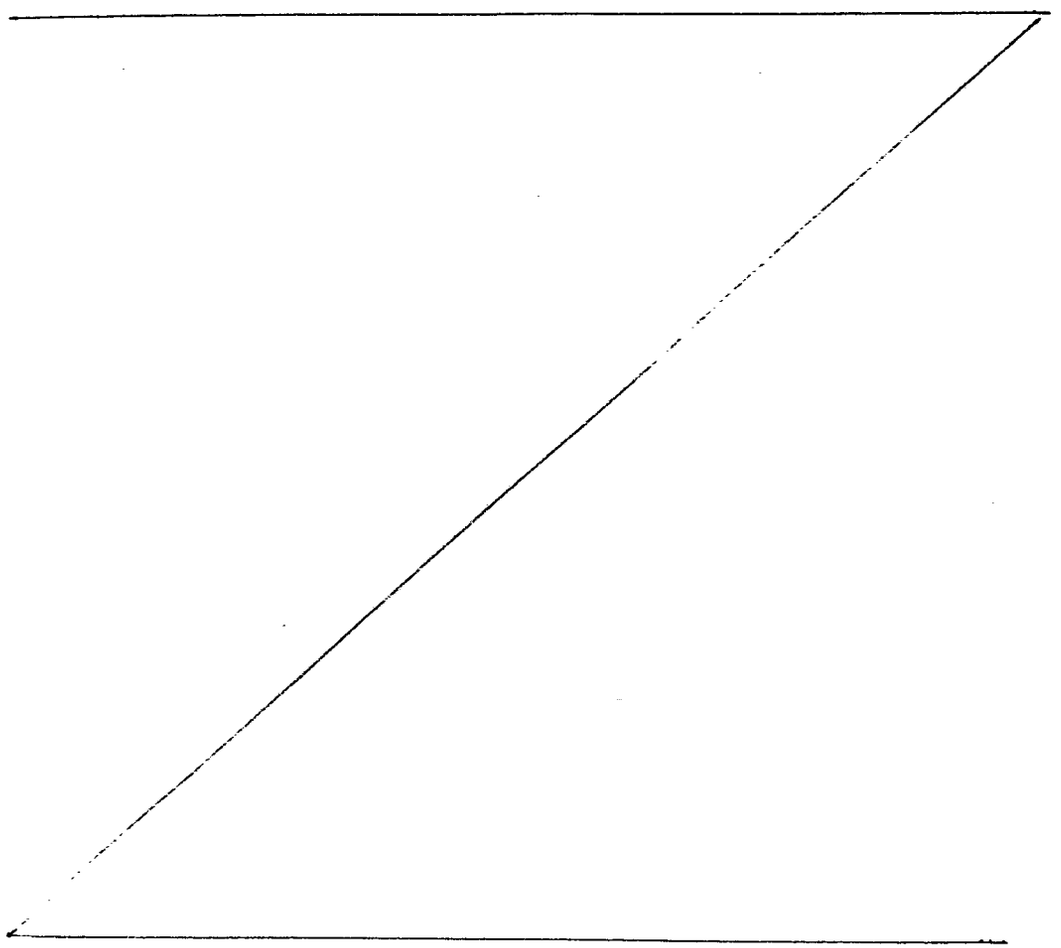
Field Of The Invention

This invention relates to a method and apparatus for economically permitting gasoline fuel burning engines to also burn a gaseous fuel.

Background Of The Invention

Various systems are known for adapting gasoline fuel burning engines to also run on compressed or liquified gaseous fuels, such as propane or the like. However, the known systems require expensive changes in the existing carburetion and acceleration systems of the vehicle. A principal object of the present invention is to provide a method and apparatus for adapting gasoline engines to also burn gaseous fuel, but in a quite simple and inexpensive manner. The gaseous fuel injection system of this invention does not include a carburator but rather instead comprises a self regulating and balancing valve which is adapted to be operated by the same mechanical linkage which operates the liquid fuel supply when the vehicle is operated on gasoline.

Applicant has realized that the only common denominator between spark plug equipped internal combustion engines is the fact that the operation of each utilizes the negative pressure or vacuum which exists in the intake manifold of the engine. This realization led to the development of a gaseous fuel injection system which is capable of delivering gaseous fuel to the intake manifold of the engine without the need of a carburator. The elimination of a carburator also eliminated the need for the extensive and expensive changes which characterize the known systems for adapting gasoline engines to also use a gaseous fuel.



Description Of The Illustrated Embodiment

Referring to the drawing, a conventional gasoline fuel system is schematically shown to include a fuel tank 10, a carburator 12, and a fuel supply line 14 leading from the tank 10 to the fuel inlet of the carburator 12. Line 14 includes a fuel pump 16 and in accordance with an aspect of the present invention is also provided with an off-on valve 18. Carburator 12 includes an accelerator pedal operated valve 20 and an air inlet 22. The outlet of the carburator 12 is connected to the intake manifold 24 of an internal combustion engine.

The gaseous fuel system of the present invention comprises a gaseous fuel storage tank 26, a gaseous fuel supply line 28 leading from the tank 26 to an inlet fitting 30 of a regulating and balancing valve 32, and off-on valve 34 located in supply line 28.

Valve 32 includes an outlet fitting 36 which is connected to an injection line 38 which delivers a metered amount of gaseous fuel from valve 32 into the intake manifold 24. According to an aspect of the invention, such gaseous fuel is discharged at a location 40 which is generally below and to the engine wall side of the location where the carburator 12 delivers a fuel air mixture into the intake manifold when gasoline is being burned in the engine.

The valve 32 may comprise a two part housing 42, 44 having flanges 46, 48 where the two housing parts 42, 44 are joined. A diaphragm 50 is located within the housing and it may include an outer peripheral portion 52 which is clamped between the flanges 46, 48.

As shown, diaphragm 50 and wall section 42 may together define a chamber 54 which is essentially closed but includes an inlet orifice 56 and an outlet orifice 58.

An inlet valve member 60 is pivotly mounted at 62, at a location offset from the inlet orifice 56. Valve member 60 includes a closure portion 64 which extends from the pivot pin 62 over to a position over the inlet orifice 56. It also includes a control arm portion 66 which projects from pivot pin 62 in the opposite direction and engages a post 68 which extends from the center of the diaphragm 50 towards the center 70 of housing part 42. Center portion 70 is shown to be in cup form and is shown to receive one end of a coil spring 72. The opposite end of coil spring 72 engages the lower (as pictured) end of post 68. The post end of control arm 66 is forked and a reduced dimension portion 74 of post 68 is received within the space between the two side parts of the fork.

Orifice control portion 64 may include a closure plug 76 constructed from soft rubber or a similar material.

As will be apparent, downward (as pictured) movement of diaphragm 50 will result in an upward (as

pictured) or opening movement of closure member 76, permitting flow of gas through orifice 56 into chamber 54. Upward (as pictured) movement of diaphragm 50 will result in a closing movement of member 76.

Valve 32 includes an accelerator pedal controlled flow control valve 78, comprising a rotary valve plug member 80 located between outlet orifice 58 and outlet fitting 36. Rotation of member 80 causes a change in the area of an orifice 82 defined immediately downstream of member 80.

A control rod 84 which moves in response to movement of the accelerator pedal is secured to the control lever portion 86 of valve 78. Lever 86 is provided with a slot 88 which receives a threaded side piece 90 on control rod 84. A clamp nut 92 threads onto side piece 90, and serves to secure linkage 84 to lever 86. As will hereinafter be described in greater detail, slot 88 provides a way of adjusting the position of valve member 80 relative to the accelerator pedal (not shown).

As shown, lever 86 may include a support shelf 94 which contains an internally threaded opening for receiving a stop bolt 96. A compression spring 98 is shown located between shelf 94 and the head bolt 96. A screwdriver is used to rotate bolt 96 for adjusting the position of its end 100 relative to the outlet fitting 36, to provide a way of limiting the amount of rotation of valve member 80.

As shown, the side of diaphragm 50 outside of chamber 52 is in communication with atmospheric pressure, such as via an opening 102 in housing part 44.

It is believed that the best location to mount the valve 32 is on the engine as close as possible to a position which is vertically in line with the carburator control arm. Valve control rod 84 is then connected at its end opposite lever 86 to the carburator control arm. This position of mounting the valve 32 will assure that any vibration or rattling of the engine will not cause motion which will adversly affect operation of the valve 32.

The manner of connecting valve 32 may be as follows. The vehicle engine is first ran on gasoline to warm it up until the automatic choke opens. Then, the gasoline line is closed by operation of off-on valve 18. The engine will continue to burn gasoline until all of the gasoline in the carburator is completely used up. Then, the user connects the control arm 84 to the accelerator linkage and preferably to the control arm on the carburator.

The flow control valve arm 86 is initially in a down position so that the valve 80 is closed. Then mouth suction is applied on the hose 38 and at the same time the screw 96 is rotated for the purpose of setting the control valve 80 to a slightly open or approximately idling speed position. Next, the lower end of conduit 38 is positioned inside the intake manifold 24, substantially immediately below the open-

ing leading from the carburator 12, on the engine block side thereof. This may easily be done by inserting a piece of copper pipe of proper length through a brass nipple which is adapted to thread into an opening provided in the manifold 24, such that when the nipple is tightened the inner end of the copper pipe is properly placed below the opening leading from the carburator, to the engine block side of the intake manifold. A short length of the copper pipe is allowed to project upwardly through the nipple, for connection to a hose which forms the remaining part of conduit 38 leading from fitting 36 to such piece of copper pipe.

The gaseous fuel storage tank 26 may be located at any convenient and legal location within the vehicle. The supply conduit 28 is connected between storage tank 26 and inlet fitting 30. After such installation has been accomplished, the off-on valve 34 is opened, the engine is started and the adjusting screw 96 is turned to set the idling position of valve 80. Then the connection is made between arm 84 and lever 86, i.e. the nut 92 is installed and tightened. The connection at 90, 92,86 provides a pivotal connection. The flow control valve 80 will regulate the amount of gas needed for the different sizes of engines. By use of the slot 88 the flow control valve can be adjusted not to open completely at maximum r.p.m., but only as desired for maximum fuel efficiency at any speed. The desired maximum open position of control valve 80 is

set by moving member 90 in position within the adjustment slot 88 before tightening of nut 92.

The size of compression spring 72 is dependent upon the stored pressure of gas within tank 26. For example, in an installation in which the storage pressure within tank 26 is approximately 200 PSI gas pressure, the compression spring 72 should provide about 150 gram force.

Storage tank 20 does not include a pressure reducing valve in its outlet. As a result of this fact, and at least partially also due to the relatively close location of chamber 54 to the manifold 24, no icing of fittings and conduits was experienced.

The off-on valves 18, 30 are preferably readily available low cost valves which are adapted to be controlled by manual choke cables.

In use of the system it is important when switching from gasoline to gaseous fuel to use up all of the gasoline that remains in the carburator before opening the gaseous fuel valve 34. If this is not done the engine will receive both gaseous fuel and gasoline and will become flooded. When switching from gaseous fuel to gasoline it may be necessary to use the starter once or twice to cause the gasoline pump to pump gasoline into the empty carburator.

Proper operation of valve 32 will produce a fluttering movement of valve member 64, 76. At high speeds "fluttering" movement will result in a rattling

sound inside valve 32 which can be detected by use of a listening device, indicating proper functioning of the valve. Gaseous fuel entering chamber 54 through orifice 56 will increase the pressure within chamber 54 while at the same time the vacuum present in intake manifold 24, communicated with chamber 54 via conduit 34, inlet fitting 36, the valve port in valve 80 and the orifice 58 will tend to lower the pressure within chamber 54. Diaphragm 50 will be constantly moving in response to the pressure and vacuum forces and as it moves it will cause a closure element 64, 70 to "flutter" as they perform to regulate the flow of gaseous fuel into and through the valve 32.

Valve 32 is self regulating and self balancing and this means that valve 32 will deliver the desired pressure of gas regardless of the supply pressure in tank 26. Valve 32 eliminates the need of a pressure regulating valve in the outlet of tank 26 and the associated problem of icing caused by decompression. Expansion through the small orifice of a pressure regulator valve results in a decrease in temperature of the gas to a level at which the gas freezes solid. Self regulating means that the valve 32 will always deliver the desired quantity of gas determined by the setting of flow control valve 80.

WHAT IS CLAIMED IS:

1. For installation in a gaseous fuel supply line leading from a gaseous fuel storage container to the intake manifold of a fuel burning engine, a regulating and balancing gas valve comprising:

housing means defining a compartment, a diaphragm within said compartment defining one wall of a chamber, with said housing means defining the remaining boundaries of such chamber, with the side of the diaphragm opposite the chamber being in communication with atmospheric pressure,

a gas inlet into said chamber, adapted for connection with a conduit leading from a gaseous fuel storage container,

an outlet from said chamber adapted for connection to the intake manifold of an engine,

an accelerator pedal controlled valve in said outlet, for varying the flow rate of gaseous fuel from said chamber in response to the position of the accelerator pedal,

inlet valve means for controlling the flow of gaseous fuel through said inlet into said chamber, including control means interconnected between the diaphragm and said inlet valve means, operable to open or increase the size of the inlet in response to inward movement of said diaphragm, and to decrease or close the inlet in response to outward movement of said diaphragm.

2. A gaseous fuel supply line leading from a gaseous fuel storage container to the intake mainfold of a fuel burning engine, and

a regulating and balancing gas valve in said line comprising:

housing means defining a compartment, a diaphragm within said compartment defining one wall of a chamber, with said housing means defining the remaining boundaries of such chamber, with the side of the diaphragm opposite the chamber being in communication with atmospheric pressure,

a gas inlet into said chamber, adapted for connection with a conduit leading from a gaseous fuel storage container,

an outlet from said chamber adapted for connection to the intake manifold of an engine,

an accelerator pedal controlled valve in said outlet, for varying the flow rate of gaseous fuel from said chamber in response to the position of the accelerator pedal,

inlet valve means for controlling the flow of gaseous fuel through said inlet into said chamber, including control means interconnected between the diaphragm and said inlet valve means, operable to open or increase the size of the inlet in response to inward movement of said diaphragm, and to decrease or close the inlet in response to outward movement of said diaphragm.

3. A method of burning gaseous fuel in a fuel burning engine which is also adapted to burn liquid fuel, and which includes means for dispersing the liquid fuel, mixing it with air, and introducing such mixture into the intake manifold of the engine, comprising:

storing the gaseous fuel within a storage tank;

when it is desired to burn gaseous fuel, closing a valve in the liquid fuel system leading to the intake manifold, and opening a valve in the gaseous fuel system, to allow gaseous fuel to flow out from such storage tank;

introducing such gaseous fuel into an inlet of a chamber which is bounded on one side by a diaphragm and on its other sides by rigid wall means, and which includes an outlet;

subjecting the opposite side of the diaphragm to atmospheric pressure;

locating a control valve in such outlet, and connecting such control valve to the accelerator pedal of the engine, so that movement of such accelerator pedal will result in movement of such control valve, to control the flow rate of gaseous fuel out from such chamber;

utilizing movement of such diaphragm to control the flow of gaseous fuel through such inlet, so that a decrease of pressure within such chamber will cause an increase in the size of the inlet and an increase of pressure within such chamber will cause a decrease in the size of such inlet; and

delivering gaseous fuel from such outlet into the intake manifold and injecting it into such manifold substantially at the location of discharge of fuel and air into the intake manifold when the engine is being operated on liquid fuel.

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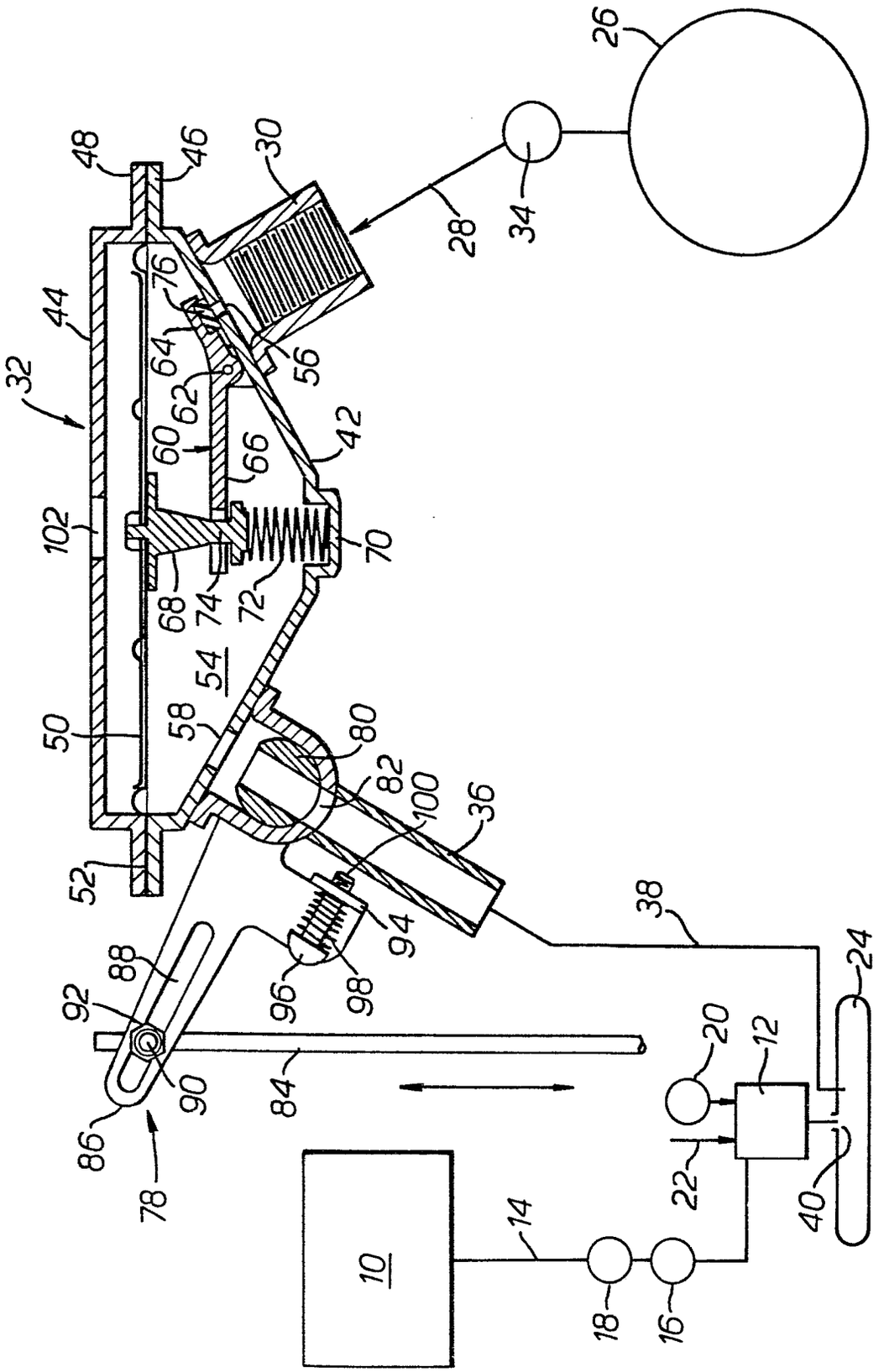
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EUROPEAN SEARCH REPORT

Application number

EP 80 30 3604.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	FR - A - 811 254 (I.G. FARBENINDUSTRIE AG) * page 1, lines 1 to 27; page 2, lines 79 to 92; fig. *	1,2
	DE - U1 - 7 729 205 (E. SCALETTI) * claim 1; pages 6 to 8; fig. 1 to 3 *	1,2
A	DE - A1 - 2 364 465 (DAIMLER-BENZ) * fig. *	
A	DE - A1 - 2 727 515 (M. LINDTNER et al.) * page 6, paragraph 2 to page 7, paragraph 1; fig. 1 *	
A	DE - C - 1 120 210 ("E.N.N.A.M." N.V.) * claim 1; fig. *	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

F 02 D 19/02

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

F 02 B 19/04
F 02 B 23/06
F 02 B 43/00
F 02 B 69/00
F 02 D 5/00
F 02 D 19/02
F 02 M 13/00
F 02 M 21/02
F 16 K 1/30
F 16 K 7/00
F 16 K 17/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	29-05-1981	CANNICI